Tektronix®

8 Series Sampling Oscilloscope
TSO820 and TSO8C17/18 Datasheet

The 8 Series Sampling Oscilloscope provides a comprehensive optical test solution for telecom and datacom applications, as well as general purpose optical component testing. The TSO8C17 and TSO8C18 optical modules provide > 30 GHz optical bandwidth, plus fully integrated Optical Reference Receivers (ORR)[1] enabling both single mode and multi-mode conformance testing at 850 nm, 1310 nm, and 1550 nm bands.

Key performance specifications

- Optical bandwidth above 30 GHz
- Single mode and multi-mode support for short and long wavelength optical testing
- Optical Reference Receiver (ORR)[1] support for standard compliance testing

Applications

- Design/verification of High-Speed Components and Systems
- Signal integrity analysis
- Compliance test for industry PAM4 standards: 50G, 100G, 200G, 400G IEEE 802.3[TM] standanrd such as 400GBASE-FR8, 400GBASEDR4, and similar optical direct detect standards.

Key features

- **New system architecture**
  - Disaggregated: Separation of the acquisition hardware and software analysis allows the data to be streamed over Ethernet to a connected PC. Users have the capability to scale their analysis platforms to their needs and can connect from anywhere on the network
  - Configurable: The TSO820 mainframe supports user-swappable current and future optical modules

- **Optical modules**
  - Accurate testing and characterization of short or long wave optical signals using the high sensitivity and low noise performance of the TSO8C17 or TSO8C18 modules
  - Optical reference receivers (ORR)[1] supports specified requirements for standards-mandated compliance testing
  - Extinction ratio measurements with built-in variable ER correction to ensure accuracy and repeatability

- **Analysis with TSOVu®**
  - TSOVu: A new software platform that runs independent of the oscilloscope mainframe on users' computers or server for both live and post-processing of acquired data
  - TSOVu offers comprehensive analysis of PAM4 optical signals. Includes support for eye diagrams, optical measurements such as TDECQ, and other standard measurements
  - Measurement plug-in designed to interface with the base software that can be dynamically installed as needed

- **High test throughput**
  - Simultaneous capture of all channels at a high sample acquisition rate of 300 kS/s
  - Sophisticated Programmatic Interface (PI) for automation environments enables the highest test throughput. Each command supports full data synchronization, eliminating the need for wait / sleep statements

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[1] Optical Reference Receiver (ORR) is a 4th order Bessel-Thomson filter with a frequency response and tolerances as defined by the standards. Tektronix optimizes the response for best nominal fit and highest quality mask test results

Compliance testing

Compliance test for 50G, 100G, 200G, and 400G IEEE 802.3[TM] standards such as 400GBASE-FR8, 400GBASE-DR4, and similar optical direct detect standards. The TSO820 Sampling Oscilloscope is also designed to support high speed NRZ standards such as 100 Gb Ethernet (100GBASE-LR4 or similar) that operates at a rate of 25.78125 Gb/s. Stay up-to-date on the latest standards changes by updating or adding new measurement plug-ins as they are released.

Disaggregated architecture

Traditional oscilloscopes perform measurements on-device with the specific processor that the instrument was shipped with. However, that processor becomes obsolete over time, and makes speed upgrades to the analysis platform impossible. The 8 Series Sampling Oscilloscope turns this notion upside-down and features a disaggregated architecture, which means that the acquisition hardware and analysis platform have been separated. Since TSOVu can be installed on any Windows 10 machine, users now have the freedom to choose the laptop readily available in the lab, a server connected to the network, or anything in between.
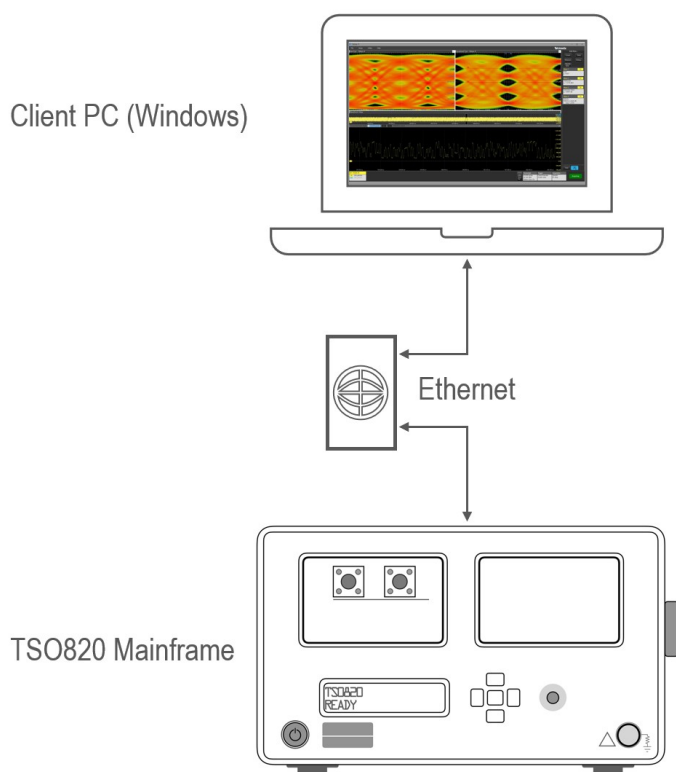
Client PC (Windows)

Ethernet

TSO820 Mainframe

Figure 1: System diagram of client PC connected to a TSO820 mainframe via local area network (LAN)

Flexibility by design

The 8 Series Sampling Oscilloscope has been designed with modularity in mind. The TSO820 mainframe features the two module slots that are compatible with TSO8C17 and TSO8C18 optical modules, as well as future other modules. The oscilloscope mainframe can be reconfigured on the spot by removing or inserting modules through the top of the instrument. As testing requirements evolve, scale or change capabilities to match current testing needs without sending the instrument in for factory reconfiguration.

When connecting to the TSO820 using TSOVu, any changes to the hardware configuration will be reflected by the user interface . The module type, serial number, calibration information, and so on are accessed via TSOVu or PI queries.

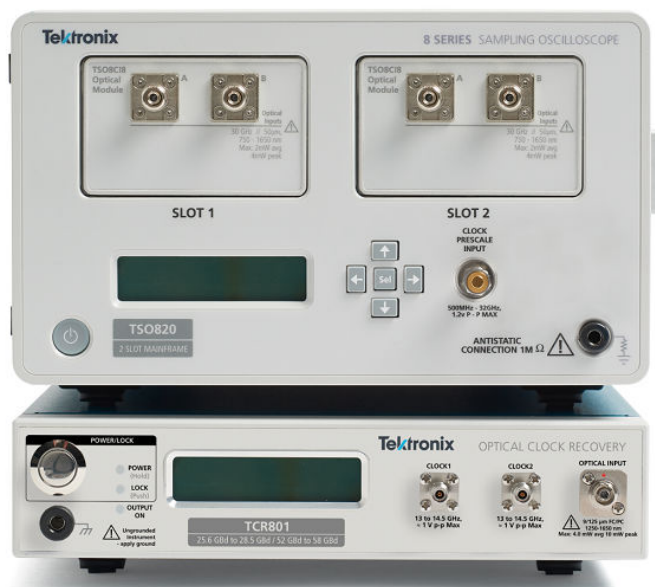*Figure 2: Plugging TSO8C18 module into TSO820 mainframe.*

Figure 3: 8 Series instruments: TSO820 mainframe, TSO8C17 / TSO8C18 (shown) optical modules

For more information regarding the TCR801, refer TCR801 Optical Clock Recovery Datasheet on *www.tek.com/*
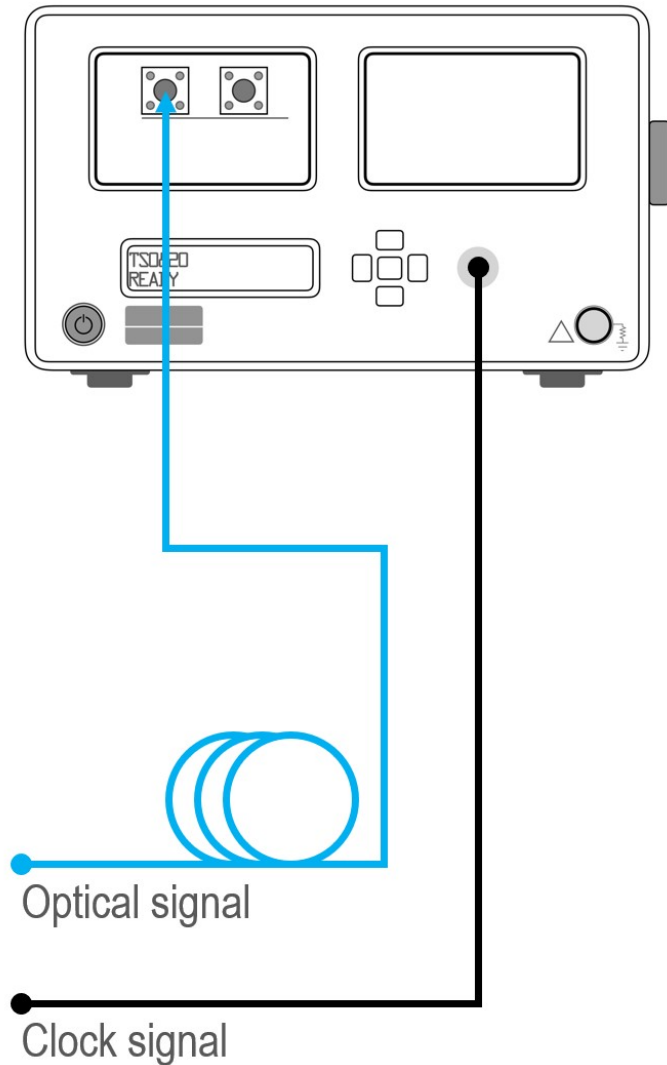
Connection diagrams

Figure 4: Connection diagram demonstrating the TSO820 mainframe with one TSO8C18 optical module, triggered directly from DUT or pattern generator
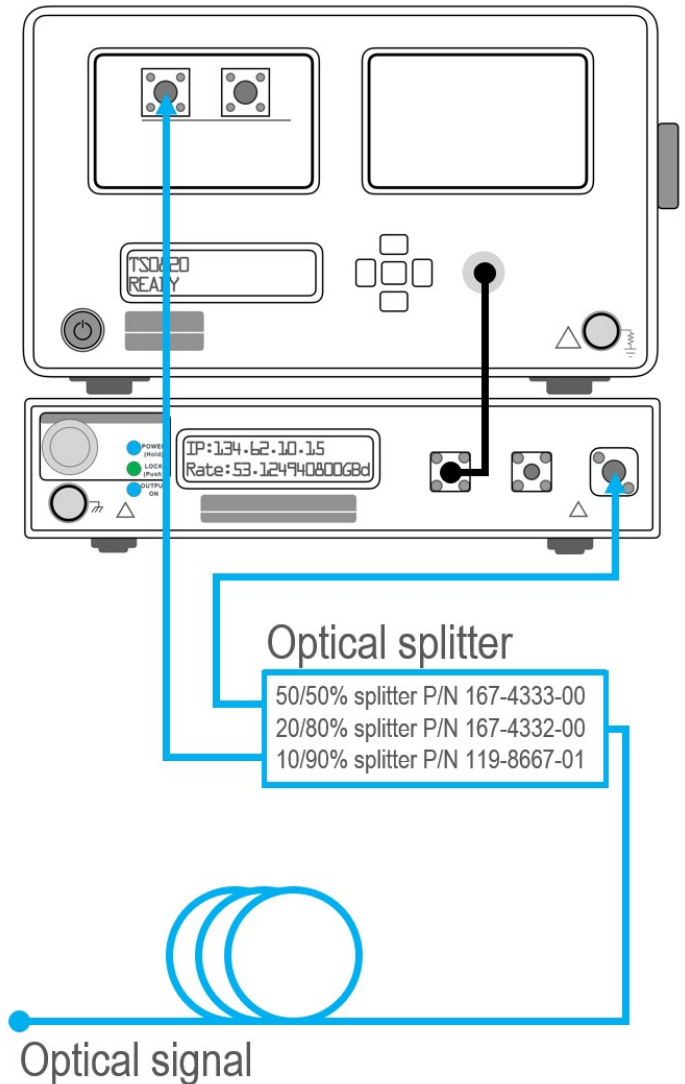

Figure 5: Connection diagram demonstrating the TSO820 mainframe with one TSO8C18 optical module, triggered by the TCR801 Optical Clock Recovery.

User interface

The 8 Series Sampling Oscilloscope features a brand-new sampling oscilloscope software architecture called TSOVu. This new software runs on a user's external Windows 10 PC and features an intuitive user interface and analysis engine for increased measurement throughput and limits oscilloscope downtime.

The communication between the PC running TSOVu and the TSO820 mainframe is based on an IEEE 802.3[TM] Ethernet network, such as 100BASE-T or 1000BASE-T. TSOVu's Programmatic Interface (PI) commands can be used in the automation environments to control instrument functionality and analysis reporting. Use TSOVu with the TSO820 Sampling Oscilloscope Mainfarme to acquire multiple channels simultaneously and analyze remotely over Ethernet or Wi-fi.

⚠️ **Note:** Wi-fi requires consistent and stable network connection for proper use.
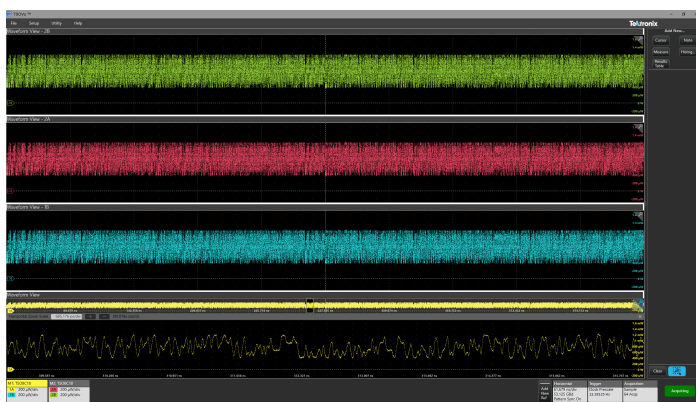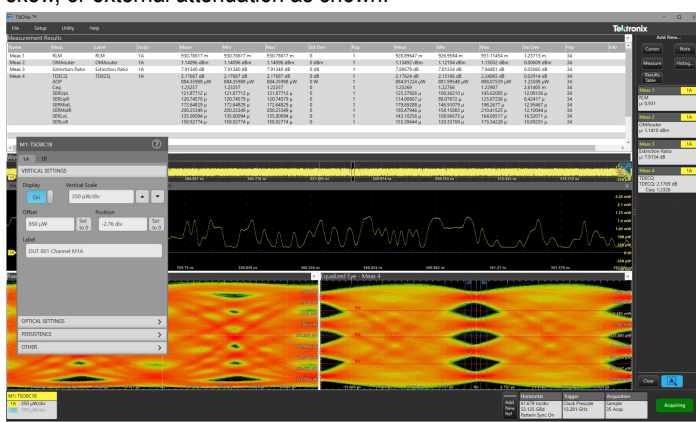

Figure 6: Example of the TSOVu session connected to a TSO820 mainframe with two TSO8C18 optical modules

Adjust vertical channel parameters individually based on the modulation type, channel bandwidth, and inherent signal characteristics like offset, skew, or external attenuation as shown:

Add reference waveforms for offline processing of previously captured data, view eye diagrams before and after TDECQ FFE equalization, and detach windows from the base software to be rearranged or resized
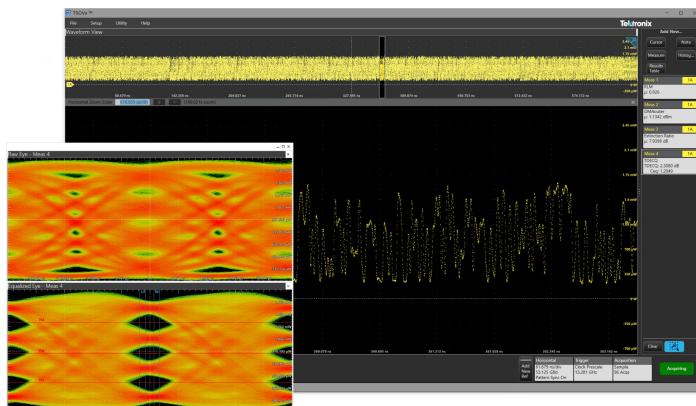
Measurement plug-in interface

Using the flexible plug-in architecture in TSOVu, measurement plug-ins that can interface with TSOVu will display directly in the Add Measurement window. This includes Tektronix' standard Pulse Measurement and PAM4 Optical Measurement plug-ins, and enables quick development of custom measurement libraries that are fully integrated in TSOVu to be called from the user interface or through PI commands.
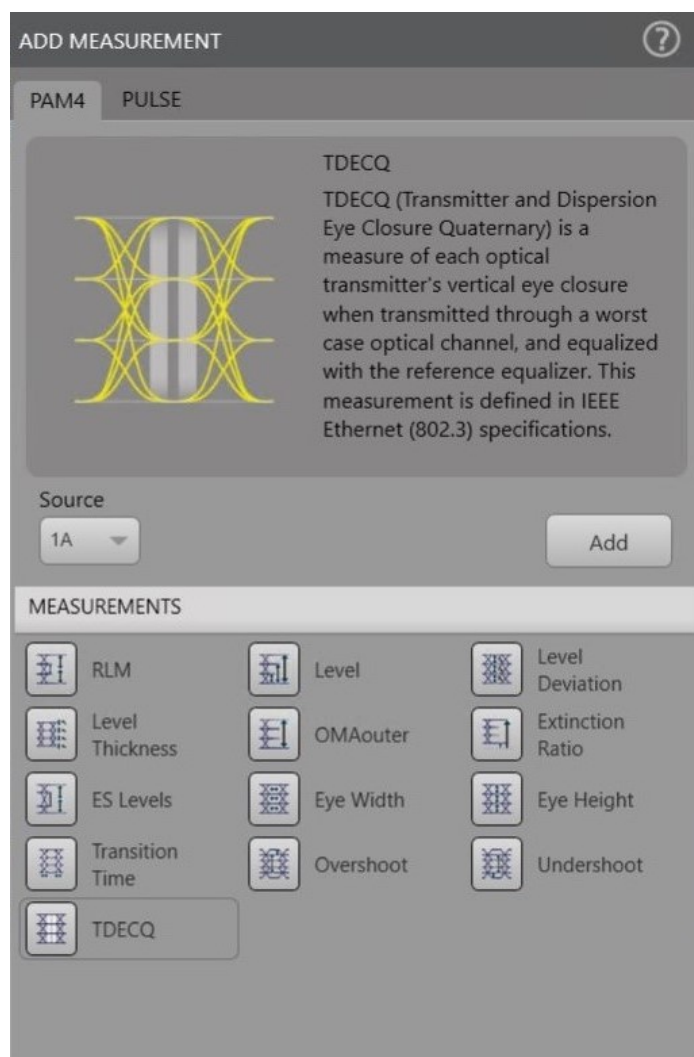

Figure 7: Example of the Add Measurement window displaying available optical PAM4 measurements. All measurements have short descriptions and can be added to live channels or reference waveforms

Supported measurements

Pulse measurements: Amplitude	High
	Low
	Amplitude
	Max
	Min
	Mid
	Mean
	Pk-Pk
	AC RMS
Pulse measurements: Timing	Period
	Frequency
	Rise
	Fall
	Positive Cross
	Negative Cross
	Positive Width
	Neagtive Width
	RMS Jitter
	Pk-Pk Jitter
	Delay
PAM4 Optical measurements	RLM
	Level
	Level Deviation
	Level THickness
	OMAouter
	Extinction Ratio
	Effective Symbol Levels
	Eye Width
	Eye Height
	Transition Time
	Overshoot
	Undershoot
	TDECQ

High-sensitivity operation accommodates lowamplitude signals

The TSO8C17 and TSO8C18 optical modules feature high input sensitivity for measurement of low power signals. This enables the user to recover full pattern acquisitions with little noise contribution from the oscilloscope, making it possible to take true and accurate measurements in conditions where signal power is low.
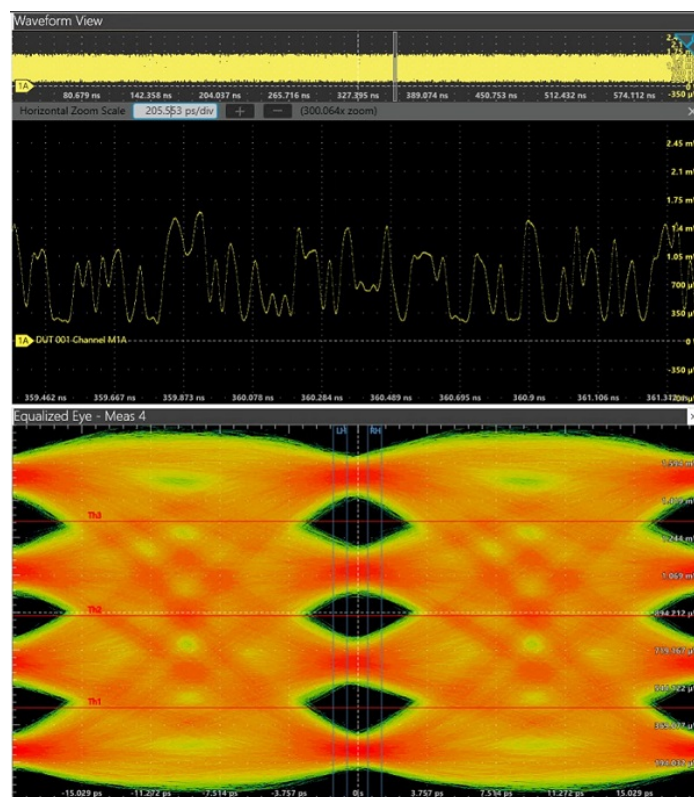

Figure 8: Example of a 53 GBd PRBS15Q signal acquired on the Tektronix TSO820 Sampling Oscilloscope with TSO8C18 optical module, triggered by the TCR801 Optical Clock Recovery

PC requirements

- Processor: AMD or Intel:

    - Minimum: AMD Ryzen 5 or Intel i5 with hyperthreading
    - Recommended: AMD Ryzen 7 or Intel i7 class processor or better.

    ⚠️ **Note:** The time to calculate mesurements, including TDECQ is inversely proportional to the processor clock speed.

- Memory:

    - Minimum: 8 GB
    - Recommended: 16 GB or more
- Disk: 256 GB SSD
- OS: Windows 10, 64 bit
- Networking: 1 Gigabit Ethernet recommended

Specifications

TSO820 Mainframe Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Vertical system

Rise time / bandwidth	Determined by the sampling modules used
Vertical resolution (nominal)	15.6 bits over the sampling modules' dynamic range

Horizontal system

Main time base / horizontal scale	1 ps/div to 1 ms/div
Record length	> 800 Msamples

Trigger system

Trigger source	Clock Prescale Input (front panel)
Clock Prescale Input	
Clock input sensitivity	200 mVp-p at 0.5 GHz to 32 GHz
Clock input range	200 mVp-p to 1.0 Vp-p (max); AC coupled
Pattern lengths supported (Pattern Sync)	Up to PRBS23 (8,388,607 symbols) inclusive
Clock input jitter in clock-eye and clock-pattern trigger modes (max)	500 MHz to 2 GHz: < 1530 fs RMS (sinusoidal trigger waveform; typical square-wave performance similar to below values)
	2 to 3 GHz: < 600 fsRMS
	3 to 9 GHz: < 580 fsRMS
	9 to 32 GHz: < 500 fsRMS

Acquisition system

Acquisition modes	Pattern Sync (sample and average), Sequential [Pattern Sync disabled] (sample and average)
Number of sampling modules accommodated	Two (2) modules
Number of simultaneously acquired inputs	Four (4) inputs
Maximum acquisition rate	300 kSa/s

Waveform measurements

System measurement rate	Supports up to 32 simultaneous measurement[2] with optional display of per-measurement statistics (min, max, mean and standard deviation)
Cursor modes	Vertical bar, horizontal bar, vertical and horizontal bar, and waveform cursors
Waveform processing	Bandwidth Enhancement/Impulse Response Correction (BWE), TDECQ equalized waveform
Histograms	Supports up to 30 histograms on multiple windows
Pulse measurements (standard)	High, Low, Amplitude, Max, Min, Mid, Mean, Peak-Peak, Period, Frequency, Rise, Fall, Positive Cross, Negative Cross, Positive Width, Negative Width, RMS Jitter, Pk-Pk Jitter, Delay
PAM4 measurements (license required)	RLM, Level, Level Deviation, Level Thickness, OMAouter, Extinction Ratio, Effective Symbol Levels, Eye Width, Eye Height, Transition Time, Overshoot, Undershoot, TDECQ

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[2] Lower limit which is applicable for complex measurements such as TDECQ

Input / output ports

Front Panel

Anti-static protection connector	Banana-jack connector, 1 MΩ
Clock Prescale Input	200 mVp-p to 1 Vp-p operational, AC coupled with maximum DC offset (-2.2 V to +2.2 V); 2 Vp-p absolute maximum

Rear Panel

Ethernet port	RJ45 connector; supports IEEE 802.3^{TM} Ethernet 100/1000BASE-T

Control

Control interface	*Ethernet port* on page 7
Device information	Instrument serial number, software version, other available using TSOVu

Physical

Height	132 mm (5.18 in.)
Width	217 mm (8.55 in.)
Depth	590 mm (23.22 in.)
Weight (with blank module)	5.4 kg (12.0 lbs.)

Environmental

Temperature

Operating	5 to 45 °C, above 1500 m de-rate 1 °C per 300 m; automatic shutdown for temperature > 55 °C ±5 °C ambient
Nonoperating	–20 to 60 °C

Altitude

Operating	3,000 m (9642 ft.); derate maximum operating temperature by 1 °C per 300 m above 1,500 m (4821 ft.)
Nonoperating	12,000 m (39,370 ft.)

Relative humidity

Operating	5 to 95% relative humidity at or below 30 °C; 5 to 45% above 30 °C to below 45 °C, non-condensing
Nonoperating	5 to 95% relative humidity at or below 30 °C; 5 to 45% above 30 °C to below 60 °C, non-condensing

TSO8C17 and TSO8C18 Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Optical inputs

Optical channel count

TSO8C17	One (1) optical channel
TSO8C18	Two (2) optical channels

Wavelength range	750 to 1650 nm
Calibrated wavelength (±20 nm)	850 nm, 1310 nm, and 1550 nm

Unfiltered optical bandwidth

Multi-mode	30 GHz
Single mode	> 30 GHz

Fiber input[3]	50 µm FC/PC

Optical return loss

Multi-mode	> 16 dB
Single mode	> 16 dB

Optical inputs

Acquisition delay adjustment range per channel	± 65 ps
Power meter range	-38 to +6 dBm at 1310 nm
Power meter accuracy (typical)	+/- [100 nW + (External Power Meter Reading) * [5% + 6% Uncertainty]

RMS optical noise (hardware; typical)

Bandwidth[4]	850 nm	1310 nm	1550 nm
12.6 GHz	4.2 µW	2.8 µW	3.0 µW
13.28125 GHz	4.3 µW	2.9 µW	3.0 µW
19.335 GHz	5.3 µW	3.7 µW	3.9 µW
21 GHz	6.2 µW	4.2 µW	4.4 µW
22.5 GHz	8.1 µW	5.0 µW	5.4 µW

RMS optical noise (hardware; maximum)

Bandwidth[4]	850 nm	1310 nm	1550 nm
12.6 GHz	6.0 µW	3.6 µW	3.9 µW
13.28125 GHz	6.0 µW	3.6 µW	3.9 µW
19.335 GHz	7.5 µW	4.5 µW	4.8 µW
21 GHz	8.3 µW	5.0 µW	5.4 µW
22.5 GHz	11.1 µW	6.7 µW	6.9 µW

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[3] Modules with fiber inputs of 50 µm can accommodate 9 µm (single mode) fibers

[4] Electrical bandwidth is a 4th order Bessel-Thomson filter

Supported Optical Reference Receivers[4]	TSO8C17 and TSO8C18	PAM2 NRZ	PAM4
		25.78125 GBd (TDEC-MM)	26.5625 GBd Single-mode and multi-mode standards of the IEEE 802.3[TM] (E.g. BW_{el} 13.28125 GHz)
		25.78125 GBd	
		27.95 GBd	53.125 GBd standards of the IEEE 802.3[TM] (E.g. BW_{el} 26.5625 GHz)
		28.05 GBd	

Physical

Height	53 mm (2.1 in.)
Width	96 mm (3.76 in.)
Depth	236 mm (10.35 in.)
Weight	
TSO8C17	0.549 kg (1.21 lbs.)
TSO8C18	0.660 kg (1.46 lbs.)

Environmental

Temperature

Operating	5 to 45 °C, above 1,500 m derate 1°C per 300 m
Nonoperating	-20 to 60 °C

Altitude

Operating	3000 m (9642 ft.); derate maximum operating temperature by 1 °C per 300 m above 1,500 m (4821 ft.).
Nonoperating	12,000 m (39,370 ft.)

Relative humidity

Operating	5% to 95% relative humidity at or below 30 °C,
Nonoperating	5% to 45% above 30 °C to below 45 °C, non-condensing
	5% to 95% relative humidity at or below 30 °C; 5% to 45% above 30°C to below 60 °C, non-condensing

Ordering information

TSO820 Mainframe

Models

TSO820	8 Series Tektronix Sampling Oscilloscope 2 Slot Mainframe

Standard accessories

Cable, Ethernet	2 m ethernet cable (CAT6/RJ45). Tektronix P/N 174-7292-00
50 Ω termination	50 Ω termination. Tektronix P/N 015-1022-01
Screw driver	T-10 screw driver. Tektronix P/N 003-1962-00
ESD Strap	6 ft coiled ESD strap. Tektronix P/N 006-3415-05

Power plug options

Opt. A0	North America Power Cord
Opt. A1	Universal EURO
Opt. A2	United Kingdom Power Cord
Opt. A3	Australia Power Cord
Opt. A4	240V North America
Opt. A5	Switzerland Power Cord
Opt. A6	Japan Power Cord
Opt. A10	China Power Cord
Opt. A11	India Power Cord
Opt. A12	Brazil Power Cord
Opt. A99	No Power Cord or AC Adapter

Language options

Opt. L0	English manual
Opt. L5	Japanese manual
Opt. L7	Simplified Chinese manual
Opt. L9	Korean manual

Service options

Opt. G3	Three Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others
Opt. G5	Five Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others
Opt. R3	Standard Warranty Extended to 3 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. R5	Standard Warranty Extended to 5 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process

Opt. C3	Calibration service 3 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 2 years calibration coverage
Opt. C5	Calibration service 5 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 4 years calibration coverage.
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Option C3)
Opt. D5	Calibration Data Report 5 Years (with Option C5)

Recommended accessories

Clock recovery instruments	TCR801: 26 and 53 GBaud Optical Clock Recovery Unit.

Optical Modules

Optical modules plug directly into one of the two slots provided by the TSO820 sampling oscilloscope mainframe.

Models

TSO8C17	8 Series Optical Module: Single Channel, Single / Multi Mode, 30GHz optical bandwidth for 50G/100G/200G/400G
TSO8C18	8 Series Optical Module: Dual Channel, Single / Multi Mode, 30GHz optical bandwidth for 50G/100G/200G/400G

Standard accessories

Optical Fiber Cleaner	Optical connector cleaner; 2.5 m. Tektronix P/N 068-327-00

Language options

Opt. L0	English manual
Opt. L5	Japanese manual
Opt. L7	Simplified Chinese manual
Opt. L9	Korean manual

Service options

Opt. G3	Three Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others
Opt. G5	Five Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others
Opt. R3	Standard Warranty Extended to 3 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. R5	Standard Warranty Extended to 5 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. C3	Calibration service 3 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 2 years calibration coverage
Opt. C5	Calibration service 5 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 4 years calibration coverage.
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Option C3)

Opt. D5	Calibration Data Report 5 Years (with Option C5)

Recommended accessories

Accessories

167-4333-00	50%/50% Single Mode FP/PC Splitter.
167-4332-00	20%/80% Single Mode FP/PC Splitter.
119-8667-01	10%/90% Single Mode FP/PC Splitter.

Software

TSOVu is available for download at *www.tek.com/downloads*

Software licenses for TSOVu are available for purchase to extend the analysis capabilities of the base oscilloscope software. The Pulse Measurement Plug-in is available free with every TSOVu; other measurement plug-ins can be enabled for operation with purchase of a valid license.

Software licensing and activation information

Optional plug-ins for TSOVu require installation of a valid license before initial use. Each software enabled feature requires its own license, and licenses can be managed within the Tektronix Asset Management System (Tek AMS). Product license management requires a login account and can be accessed via the Tek AMS web site address (*www.tek.com/products/product-license*).

There are four types of licenses available for plug-in applications which are explained below:

- **NLP**: Node-locked perpetual licenses enable oscilloscope features permanently, are assigned to the Host ID of an instrument or TSOVu software, and guarantee software updates for the first 12 months. Software updates after the first 12 months are available with 1-year renewal.
- **FLP**: Floating perpetual licenses enable oscilloscope features permanently, can be transferred between Host IDs (mainframe or software), and guarantee software updates for the first 12 months. Software updates after the first 12 months are available with 1-year renewal.
- **NL**: Node-locked subscription licenses enable oscilloscope features for a predefined time period, are assigned to the Host ID of an instrument or TSOVu software, and guarantee software updates for the duration of the license.
- **FL**: Floating subscription licenses enable oscilloscope features for a predefined time period, can be transferred between Host IDs (mainframe or software), and guarantee software updates for the duration of the license.

⚠️ **Note:** Use the Tektronix Asset Management system to check in and check out floating licenses.

License

PAM4-O	PAM4 Optical Measurement Plug-in

License options (required)

TSO8SW-NLP	Node-Locked Perpetual License
TSO8SW-FLP	Floating Perpetual License
TSO8SW-NL1	Node-Locked 1-Year Subscription License
TSO8SW-NL3	Node-Locked 3-Year Subscription License
TSO8SW-FL1	Floating 1-Year Subscription License
TSO8SW-FL3	Floating 3-Year Subscription License

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